



MARKSCHEME

May 2014

BIOLOGY

Higher Level

Paper 3

Option D — Evolution

1. (a) both show a (similar) range of life spans;
both have a peak at 12–14 hours;
SFS flies have higher mean life span than NFS flies / vice versa;
(some) SFS flies live longer than 16 hours, NFS flies do not;
(some) NFS flies live less than 10 hours, SFS flies do not; *[3 max]*
- (b) SFS has the drier climate as SFS flies live longer (when subjected to drought stress);
both SFS and NFS have similar climates as both SFS and NFS flies have peak at 12–14 hours; *[1 max]*
- (c) NFS and SFS flies have different gene pools;
abiotic differences between the two slopes create different selection pressures;
genes/alleles for advantageous characteristics passed on from one generation to the next/become genetically different over time;
may not mate / reproductive barriers/isolation leads to speciation;
abiotic/geographical differences may not be sufficient to cause reproductive barrier;
the gene pools may not be separated if flies can fly between sides of canyon/mix at base of canyon; *[3 max]*

2. (a) (i) the time taken for radioactivity (of a radioisotope) to fall to half of its original level / for half of the atoms of the isotope to decay [1]
- (ii) ^{40}K decays into ^{40}Ar ;
ratio/proportion of ^{40}K to ^{40}Ar indicates the age of the rock/fossil;
half-life of ^{40}K is 1250 million/1.25 billion years;
 ^{40}K can (only) be used to date very old samples/older than 100 000 years; [2 max]
Do not accept if make reference to age less than 100 000 years.
- (b) (i) $200 - 168 = 32$ flies had short wings
 $q^2 = 32 / 200 = 0.16$
 $q = 0.4$
 $p = 0.6$
 $2pq = 0.48$; } *Award [1] for correct working.
(Looking for the logic of the working)*
- percentage of heterozygotes = 48 %; [2]
Award [1] for correct answer.
- (ii) large population/random mating/no selection/no migration/no mutation [1]
*Award [1] for any **two** correct answers. Mark the first two answers given.*
- (c) a group of organisms consisting of all descendants from a common ancestor [1]
3. eukaryotic cells contain mitochondria/chloroplasts that are not found in prokaryotic cells;
organelles evolved from (independent/free living) prokaryotes that were taken into/engulfed by larger cells by endocytosis;
these cells were not digested/survived in mutualistic/symbiotic relationship;
they continued to carry out respiration/photosynthesis;
mitochondria/chloroplasts grow and divide like cells;
mitochondria/chloroplasts have a loop of/naked DNA like prokaryotes;
mitochondria/chloroplasts have 70S ribosomes like prokaryotes to synthesise proteins;
mitochondria/chloroplasts have double membranes expected when taken into a vesicle by endocytosis;
thylakoids (in chloroplasts) similar to structures containing chlorophyll in prokaryotes; [6 max]

Option E — Neurobiology and behaviour

4. (a) 0.16 mg min^{-1} (*units needed*) [1]
Allow answers in the range 0.15–0.17.

- (b) *hypothesis supported:*
 general increase in food collection over the twelve day period;
 large increases day 1–2/day 6–7/day 10–11;

hypothesis not supported:
 most food collected on day 7;
 on some days there are declines / days 3–5/8–10 no increase overall / large decline day 7–8;
 large error bars so data very variable/much overlap between data points;
 only 38 bees in study/sample size too small for drawing valid conclusions; [3 max]

- (c) (weather) variations in temperature/some days warm, some days cold/rainfall/wet days, dry days / in wind speed;
 flowers produce more nectar on some days than on others / different flowers open on different days / more flowers open on some days / flowers different distances away so time spent travelling differs;
 bees needed for other duties – defending colony/swarming/ventilating colony;
 harvesting behaviour develops after day 1 as foragers find flowers/communicate; [2 max]

5. (a) sound waves/vibrations in air cause ear drum/tympanic membrane to vibrate;
 vibrations amplified by middle ear bones/ossicles/malleus, incus, stapes;
 causes oval window/fluid in cochlea to vibrate;
 stimulates mechanoreceptors/hair cells;
 auditory nerve passes nerve impulse to brain; [3 max]

- (b) (i)
- | Rods | Cones |
|--|--|
| function well in dim light / more sensitive to low light | function well in bright light; |
| absorb all wavelengths of visible light / not responsible for colour vision | sensitive to red, green or blue wavelengths / responsible for colour vision; |
| poor visual acuity / impulses from several rods pass to a single neuron in the optic nerve | good visual acuity / impulses from a single cone pass to a single neuron in the optic nerve; |
- [2 max]

Do not accept “rods detect black and white images”.

- (ii) (bright) light detected by photoreceptors/rods/cones in retina of eye;
 (sensory) impulses/messages sent to brain along optic nerve;
medulla oblongata/brain stem processes impulses;
 (motor) impulses/messages sent to (circular) muscles of iris (which contract);
 pupils constrict; [3 max]

6. development of bird song has both innate and learned components;
when birds hatch they may possess a basic song (crude template);
species specific (so inherited/innate/genetic);
after hatching young birds hear songs from adults of their species;
(so learn as) mimic/memorise/modify the basic template;
song does not develop properly if the young bird does not hear other members of its
species singing;
some birds have a sensitive period of development when they learn;
later young birds practise what they have heard;
song becomes modified/improved to form mature adult song/ song perfected when birds
become sexually mature;

[6 max]

Marks can be awarded if specific named example is used containing the points above.

Option F — Microbes and biotechnology

7. (a) *cases of malaria: 150 (accept answers in the range 145–155)*
monthly rainfall: 165 mm (accept answers in the range 160–170) **[1]**
Both needed for [1].
- (b) both graphs show fluctuating patterns;
 malaria rises/falls later than/after rainfall;
 malaria peaks in July, rainfall peaks in May/Apr–May;
 June to November – little variation in rainfall, decline in cases of malaria;
 both decline August to December / during Mar–Apr malaria declines while rain
 fall increases;
 both show lowest value in December; **[2 max]**
- (c) *hypothesis supported:*
 increased rainfall is followed by increased malaria / strong positive correlation
 between rainfall and number of (future) cases of malaria;
 rainfall provides pools for mosquito larvae to survive (when adults emerge later
 they spread the disease);
- hypothesis not supported:*
 very large values of standard deviation suggests data is unreliable / malaria data
 less reliable than rainfall;
 correlation between malaria cases and rainfall does not prove causation; **[2 max]**
- (d) temperature fluctuations;
 cycles in breeding and populations of mosquitos;
 cycles in populations of malaria parasites in human hosts;
 malaria only identified when symptoms show;
 immigration of infected workers to tea plantations;
 seasonal spraying of mosquitos/insecticide (causes population decline); **[2 max]**

8. (a) (i) symptom;
transmission;
treatment;

[3]

eg Salmonella food poisoning

symptoms: diarrhoea/fever/abdominal cramps/Reiter's syndrome.

transmission: by contact after poor personal hygiene/eating contaminated food (not properly cooked)/transferred from faeces of pets/from reptiles/poor kitchen hygiene/raw eggs/unpasteurised milk.

treatment: rehydration/lots of drinking/intravenous fluids/antibiotics.

Award [1 max] for each symptom, transmission and treatment.

Award [2 max] if candidate does not mention the type of food poisoning.

"Bacterial food poisoning" is too vague.

Example given must be verifiable.

- (ii) *acids:*
low pH/pickling/preservation in vinegar restricts growth of microbes/denatures enzymes;
sugar:
sugar (added to food) dehydrates microbes so it restricts growth / microbes lose water by osmosis;

[2]

(b)

Intracellular (<i>Chlamydia</i>)	Extracellular (<i>Streptococcus</i>)
lives inside cells of host	lives outside host cells;
does not produce toxins/no toxins to irritate tissues/does not damage cells	produces toxins/damages cells;
host may not be aware of infection/asymptomatic	produces symptoms (sore throat) so host aware of infection;
not targeted by immune system / (usually) long-term infection	targeted by immune system / (usually) short-term infection;
sexually transmitted disease / infectious conjunctivitis	respiratory infection / pneumonia / skin infections;

[2 max]

Answers do not need to be in table format.

9. prion hypothesis has protein as infecting agent;
prions are abnormal/misfolded forms of proteins (already present);
name of prion protein is called major prion protein/protease-resistant protein/PrP^{SC}/CD230;
the (infecting) protein is found in the brain;
prions can cause normal proteins to change (to abnormal/misfolded) shape;
misfolded proteins form chains/agglutinate/accumulate;
cause chain reaction/positive feedback creating more and more abnormal proteins;
chains interfere with normal cellular functions/cause disease symptoms;
prion hypothesis supported as no foreign/viral/bacterial DNA/RNA found;
named example of prion disease *eg* scrapie/CJD/BSE/kuru;

[6 max]

Option G — Ecology and conservation

10. (a) 2006 [1]
- (b) increases steadily from 1998 to 2002 and plateaus between 2002 and 2006;
overall increasing trend / lowest percentage in 1998 and highest in 2006; [1 max]
- (c) fledging success is always greater than breeding success;
show opposite trends before 2002; (*accept a description*)
follow (closely) similar trends after 2002; (*accept a description*)
maximum difference (in percentage) in 1998;
difference remains smallest between 2002 and 2006; [2 max]
- (d) many of the eggs laid do not hatch but those that do hatch fledge successfully [1]
- (e) eggs may have been laid late in the breeding season so warmer temperatures /
shorter time for parental care (leading to low fledging success);
predation of parents/chicks;
weather conditions at time of fledging may have been unusually harsh;
food sources may have been reduced; [2 max]
11. (a) (i) temperature;
water;
breeding sites;
food supply;
territory;
predators / parasites / pathogens; [2 max]
- (ii) only one species can occupy a niche indefinitely;
more than one species results in competition for breeding sites/food/other
resource;
one species will disappear from the ecosystem/be excluded; [2 max]
- (b) sufficiently large sample size/area of study for both capture and recapture
samples;
appropriate time interval between capture and recapture;
marking techniques must be suitable for the animal species being studied /
marking must not directly harm/increase chance of predation/bias results;
 $\frac{n_1 \times n_2}{n_3}$ gives estimate of population size;

$$\left. \begin{array}{l} n_1 = \text{number captured in first sample} \\ n_2 = \text{number captured in second sample} \\ n_3 = \text{number in second sample that are marked} \end{array} \right\} \begin{array}{l} \text{All three needed for} \\ \text{the mark;} \end{array}$$
[3 max]

12. alien species is one introduced (by humans) to an area in which it does not naturally occur;
inter-specific competition – competition between different species for resources/ food/light/space/other valid answers;
valid example stated *eg* in the UK the larger grey squirrel is better adapted to utilize food resources than the native red squirrel / *eg* *Salvinia molesta*/floating fern grows very rapidly over the surface of tropical lakes eliminating native plant species;
[2 max]

predation – one species feeding on another;
valid example stated *eg* lampreys in St. Lawrence Seaway depleting stocks of lake trout and whitefish / *eg* rats (*Rattus rattus*) introduced onto islands in New Zealand fed on eggs/young birds/adults of native species (which were not behaviourally able to resist them); **[2 max]**

species extinction – one species causing another to become extinct;
valid example stated *eg* many species of cichlids in Lake Victoria extinct after introduction of Nile perch (introduced to increase fish population) ; **[2 max]**

biological control of pest species – species introduced deliberately to control a pest;
valid example stated *eg* purple loosestrife in USA and Canada invades wetlands and displaces native species / *eg* *Salvinia* weevil introduced to feed on *Salvinia*/floating fern that has damaged many lakes in the (sub) tropics; **[2 max]**

[6 max]

Option H — Further human physiology

13. (a) $510 - 90 = 420$ (beats min^{-1}) (*accept 420/–420/decrease of 420*) [1]
Accept answers in the range 400–440.
- (b) during diving heart rate decreases while arterial blood pressure increases;
 swimming causes little/no change from control in both heart rate and arterial blood pressure;
 diving produces greater change than swimming in heart rate and arterial blood pressure;
 little/no differences between rats diving voluntarily or submerged involuntarily; [2 max]
Award [1] if candidate describes swimming and diving for heart rate and then swimming and diving for arterial bp correctly.
- (c) diving rats hold their breath while swimming rats do not;
 so heart rate decreases/peripheral blood vessels constrict in diving/submerged rats;
 swimming rats have no need for the diving response so little/no change from control;
 constriction of blood vessels in diving rats raises arterial blood pressure;
 diving response conserves oxygen (for essential functions); [2 max]
- (d) heat loss (from skin) is greater in cold water therefore vasoconstriction is greater / vice versa;
 diving response slows heart rate so less blood flows to skin so less heat lost in cold water;
 increased vasoconstriction increases arterial blood pressure;
 vasoconstriction/increased blood pressure helps to maintain core temperature in cold water;
 decrease in body temperature causes heart rate to slow; [2 max]
14. (a) (i) *steroid hormone:* oestrogen/progesterone/testosterone;
protein hormone: ADH (vasopressin)/insulin/TRH;
 other valid examples; [2 max]
- (ii) presence of food/stretching of stomach stimulates endocrine glands (in stomach wall);
 gastrin secreted;
 gastrin/hormone stimulates increased secretion of HCl; [2 max]
- (b) increased CO_2 in blood / lower blood pH;
 detected by chemosensors/chemoreceptors/receptors in aortic/carotid arteries;
 nerve impulses/messages sent to breathing centre of medulla/brain;
 breathing centres/medulla also monitor blood pH/ CO_2 ;
 (more) nerve impulses/messages sent to diaphragm and intercostal muscles (causing increased muscle contraction); [3 max]

15. erythrocytes have a lifespan of approximately 120 days;
erythrocytes rupture releasing hemoglobin into bloodstream;
phagocytosis removes hemoglobin/erythrocytes;
by Kupffer cells/macrophages;
hemoglobin split into heme and globin;
globins hydrolysed into amino acids;
iron removed from heme;
(heme) converted into (biliverdin then) bilirubin (bile pigment);
iron stored/released into blood;

[6 max]
